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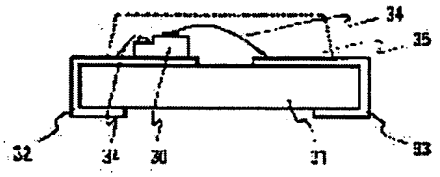
(54) SEMICONDUCTOR LIGHT-EMITTING DEVICE AND METHOD FOR MANUFACTURING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a semiconductor light-emitting device and a method for manufacturing the same wherein the device is made thin by employing an LED chip whose thickness is reduced by either rendering a substrate for laminating a semiconductor considerably thin or designing the chip as not using any substrate.
SOLUTION: This device comprises an emission element chip 30 which has a lamination of semiconductor layers 3, 4 and 5 to form an emission layer and the emission element chip 30 is so formed as to have a thickness of not larger than 50 μm along the direction of lamination of the semiconductor layers. In the case where a chip-type light-emitting device is manufactured, the device is constituted of an insulating substrate 31 which is provided with terminal electrodes 32 and 33 at both ends thereof, the emission element chip 30 which is mounted on the insulating substrate 31 with one of electrodes (an n-side electrode 9) formed thereon being electrically connected to one terminal electrode 32, a wire 34 for electrically connecting the other electrode (a p-side electrode 8) on the emission element chip 30 to the other terminal electrode 33, and a resin package 35 for covering the emission element chip 30.

(a)



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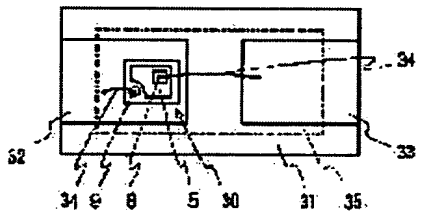

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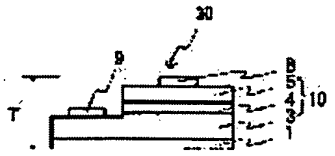

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The semi-conductor light emitting device whose semi-conductor layer is the semi-conductor light emitting device which has the light emitting device chip by which a laminating is carried out that a luminous layer should be formed and whose thickness of the direction where the laminating of said semi-conductor layer of said light emitting device chip is carried out is 50 micrometers or less.
[Claim 2] The semi-conductor light emitting device according to claim 1 which consists of the insulating substrate by which a terminal electrode is prepared in both ends, the light emitting device chip for which one electrode is electrically connected with one side of said terminal electrode while mounting on this insulating substrate, a connecting means which connects electrically the electrode of another side of this light emitting device chip with another side of said terminal electrode, and a resin package which covers the perimeter of said light emitting device chip.
[Claim 3] The semi-conductor light emitting device by which the front-face side of the semi-conductor layer by which a laminating is carried out that a luminous layer should be formed on a metal substrate is stuck by electroconductive glue, and it connects with this semi-conductor layer electrically, and comes to prepare an electrode metal in the semi-conductor layer side of this said semi-conductor layer side stuck by which a laminating is carried out, and the opposite side.
[Claim 4] The semi-conductor light emitting device according to claim 3 which said semi-conductor layer by which a laminating is carried out becomes from a CHITSU-ized gallium system compound semiconductor.
[Claim 5] (a) On a wafer-like substrate, carry out the laminating of the semi-conductor layer that a luminous layer should be formed, and form the semi-conductor laminating section. (b) A support substrate is stuck after forming an electrode in the front-face side of this semi-conductor laminating section. (c) Grind the substrate with which said semi-conductor laminating section was prepared from a rear-face side, and cutting separation is carried out from the (d) wafer at each light emitting device chip. (e) Process of the semi-conductor light emitting device characterized by removing said support substrate after mounting by turning down the field where this light emitting device chip was ground, and making wirebonding the electrode by the side of the front face of said semi-conductor laminating section which carried out (f) exposure.
[Claim 6] It sticks with electroconductive glue so that a metal plate may be used for said support substrate and it may connect with the 1st electric conduction form semi-conductor layer of said semi-conductor laminating section electrically at the (b) process in an approach according to claim 5. (e) Process of the semi-conductor light emitting device which connects electrically the 2nd electric conduction form semi-conductor layer and external electrode terminal of the semi-conductor laminating section which turns this support substrate side down at - (f) process, mounts said light emitting device chip, and is exposed by said ground substrate or this polish.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to thin shape-ization of the semi-conductor light emitting device chip with which the laminating of the semi-conductor layer is carried out that a luminous layer should be formed. In more detail, a semi-conductor layer makes very thin thickness of the direction by which a laminating is carried out, and is related with the semi-conductor light emitting device of the super-thin shape in the high brightness which fully secured luminescence area, and its process.
[0002]
[Description of the Prior Art] Conventionally, as the light emitting device chip (henceforth an LED chip) of a semi-conductor light emitting device is shown in drawing 6 (a), on the GaP substrate 11 of n form, epitaxial growth of the GaP layer 12 of p form is carried out, pn junction is formed, and the thing of the structure where the n lateral electrode 14 is formed at the rear-face side of the p lateral electrode 13 and a substrate is used for the front-face side of the semi-conductor layer by which the laminating was carried out.
[0003] Moreover, for example like the semi-conductor light emitting device of a blue system, the thing of the structure where the laminating of the CHITSU-ized gallium system compound semiconductor layer is carried out on the insulating substrate which consists of sapphire etc. is formed by forming both the p lateral electrode 28 and the n lateral electrode 29 in the front-face side, as the schematic diagram of an example of the LED chip is shown in drawing 6 (b). The thing of this structure for example, on wafer-like silicon on sapphire 21 For example, the n form layer 23 to which epitaxial growth of the GaN of n form was carried out (cladding layer), The barrier layer 24 which bandgap energy becomes from the ingredient which becomes smaller than that of a cladding layer, for example, an InGaN system (ratio of In and Ga is the same the following which means that it may change variously) compound semiconductor, The laminating of the p form layer (cladding layer) 25 which consists of GaN of p form is carried out, and it connects with the p form layer 25 of the front face electrically. The p lateral electrode 28 The LED chip is formed by connecting with the n form layer 23 which a part of semi-conductor layer by which the laminating was carried out was etched, and was exposed electrically, and forming the n lateral electrode 29.
[0004] About 260 micrometers of these LED chips are formed in the thickness of about 300 micrometers on all sides, for example, and by the thing of the structure shown in drawing 6 (b), they are four way types about 360 micrometers, and are formed in the thickness of about 100 micrometers what is shown in drawing 6 (a), for example. And the light emitting device of a chip mold is formed by mounting these LED chips 30 so that one terminal electrode 32 of an insulating substrate 31 and one electrode with which the terminal electrodes 32 and 33 were formed in both ends may be connected electrically, as shown in drawing 7 , and wirebonding of the electrode 13 of another side of the LED chip 30 being carried out to the other-end child electrode 33 by the gold streak 34, and covering it with the resin package 35 etc.
[0005]
[Problem(s) to be Solved by the Invention] In recent years, with development and a miniaturization of a portable telephone, PHS, etc. of a pocket device, the request of a miniaturization of electronic parts increases further, in the chip mold light emitting device, especially, a thin thing is required and the thing about 0.5mm or less is demanded for the whole thickness. However, as mentioned above, if the conventional LED chip has about 100-300 micrometers of the thickness and the tooth space for the thickness of an insulating substrate and wirebonding, the thickness of a resin package, etc. are taken into consideration, unless the thickness of an LED chip is set to about at least 0.1mm or less, it cannot set the whole thickness to about 0.5mm or less.
[0006] Moreover, when the LED chip with which a conductive semi-conductor is used as a substrate like GaAs has many which absorb the light which emits light by the luminous layer and its thickness of a substrate is thick, the light which progressed to the substrate side among the light which emits light by the luminous layer and is emitted on all sides is almost absorbed, and it becomes useless, and has the problem that luminous efficiency falls.
[0007] Furthermore, on an insulating substrate as shown in above-mentioned drawing 6 (b), with the LED chip by which a laminating is carried out, a semi-conductor layer cannot prepare one electrode, but must connect both electrodes to the rear-face side of an LED chip by wirebonding. Therefore, while becoming the hindrance of a miniaturization, it is also the cause of the increase of a man day of an assembly.
[0008] On the other hand, while a semi-conductor layer can chip-ize on an insulating substrate with the LED chip by which a laminating is carried out using cleavability, the semiconductor device which removes the substrate for sticking the conductive substrate which consists of a semi-conductor on the front face of the semi-conductor layer by which the laminating was carried out so that wirebonding of both electrodes might not be carried out and an electrode could be taken out from both sides of an LED chip, and carrying out the laminating of the semi-conductor layer, and its process are indicated by JP,9-8403,A. However, after preparing the metal which can take ohmic contact also to the semi-conductor substrate it not only prepares the metal which takes ohmic contact, but stuck on the front face of the semi-conductor layer by which a laminating is carried out by the approach of sticking a semi-conductor substrate, while having to stick, an electrode must be further prepared in the field of the opposite side of the stuck semi-conductor substrate. In order to obtain this ohmic contact, while adhering the metal suitable for a semi-conductor substrate, annealing treatment must be carried out, and there is a problem that a man day increases very much.
[0009] By having been made in order to solve such a problem, making very thin the substrate which carries out the laminating of the semi-conductor, or losing, this invention makes thickness of an LED chip thin, and aims at offering the approach of manufacturing the semi-conductor light emitting device and it which were thin-shape-ized.
[0010] Also in the semi-conductor light emitting device which carries out the laminating of the semi-conductor layer on an insulating substrate, and does not obtain a colander, other purposes of this invention are to offer the semi-conductor light emitting device which

has the LED chip of the structure which can form it easily by the small man day, and its process while being able to take out an electrode from vertical both sides of an LED chip, respectively.
[0011]
[Means for Solving the Problem] It has the light emitting device chip with which the laminating of the semi-conductor layer is carried out that the semi-conductor light emitting device by this invention should form a luminous layer, and the thickness of the direction where the laminating of said semi-conductor layer of this light emitting device chip is carried out is formed in 50 micrometers or less.
[0012] After carrying out the laminating of the semi-conductor layer and sticking a support substrate on a substrate at that front-face side so that it may mention later in order to form this thin LED chip for example, a substrate is ground and it is made thin, or it loses, and after mounting an LED chip, it is obtained by removing a support substrate. When an LED chip becomes thin, while a thin semi-conductor light emitting device is obtained as a whole, a substrate can become thin and the absorption-of-light loss by the substrate can be decreased to minimum.
[0013] The insulating substrate by which a terminal electrode is prepared in both ends, and the light emitting device chip for which one electrode is electrically connected with one side of said terminal electrode while mounting on this insulating substrate, When it constitutes from a connecting means which connects electrically the electrode of another side of this light emitting device chip with another side of said terminal electrode, and a resin package which covers the perimeter of said light emitting device chip and thickness uses a thing 50 micrometers or less for said light emitting device chip, a thin chip mold light emitting device is obtained. A connecting means means the means which can connect electrically [the direct connection by bonding with a wire, a bump, electroconductive glue, etc.] here.
[0014] If the front-face side of the semi-conductor layer by which a laminating is carried out that a luminous layer should be formed on a metal substrate is stuck by electroconductive glue, it connects with this semi-conductor layer electrically and the electrode metal is prepared in the semi-conductor layer side of this said semi-conductor layer side stuck by which a laminating is carried out, and the opposite side A metal substrate can be used as an electrode which is one side as it is, even if the substrate at the time of carrying out the laminating of the semi-conductor layer is an insulating substrate, an electrode is prepared in the semi-conductor layer exposed by all removing the substrate, and an electrode can be taken out from both sides of an LED chip, respectively. The front-face side of a semi-conductor layer means the exposure side of the semi-conductor layer by which a laminating is carried out later here.
[0015] If said semi-conductor layer by which a laminating is carried out consists of a CHITSU-ized gallium system compound semiconductor, especially since a CHITSU-ized gallium system compound semiconductor can obtain the LED chip which can take out both sides to an electrode in the semi-conductor light emitting device of the blue system which cannot take out an electrode from both sides easily since the laminating of the semi-conductor layer is carried out on silicon on sapphire in many cases by the easy production process, it is desirable.
[0016] A CHITSU-ized gallium system compound semiconductor is III here. The compound of Ga of a group element, and N of V group element, or III III of others [Ga / a part of / of a group element], such as aluminum and In, The semi-conductor which consists of a compound which a part of N of the thing permuted by the group element and/or V group element permuted by other V group elements, such as P and As, is said.
[0017] On a (a) wafer-like substrate, the process of the semi-conductor light emitting device of this invention carries out the laminating of the semi-conductor layer that a luminous layer should be formed, and forms the semi-conductor laminating section. (b) A support substrate is stuck after forming an electrode in the front-face side of this semi-conductor laminating section. (c) Grind the substrate with which said semi-conductor laminating section was prepared from a rear-face side, and cutting separation is carried out from the (d) wafer at each light emitting device chip. (e) After mounting by turning down the field where this light emitting device chip was ground, said support substrate is removed and wirebonding is made the electrode by the side of the front face of said semi-conductor laminating section which carried out (f) exposure. According to this approach, an LED chip with the above-mentioned thin thickness can be obtained easily.
[0018] It sticks with electroconductive glue so that a metal plate may be used for said support substrate and it may connect with the 1st electric conduction form semi-conductor layer of said semi-conductor laminating section electrically at the aforementioned (b) process. Turn this support substrate side down at the - (f) process (aforementioned [e]), and said light emitting device chip is mounted. By connecting with the 2nd electric conduction form semi-conductor layer of the semi-conductor laminating section exposed by said ground substrate or this polish electrically, and carrying out wirebonding, the LED chip which can take out an electrode from both sides can be obtained easily.
[0019] The 1st electric conduction form and the 2nd electric conduction form mean that p form or n form of another side is the 2nd electric conduction form here, when either polar n form of a semi-conductor and p form are made into the 1st electric conduction form.
[0020]
[Embodiment of the Invention] Next, the semi-conductor light emitting device of this invention is explained, referring to a drawing. The cross section of 1 operation gestalt of the semi-conductor light emitting device of this invention and flat-surface explanatory view using the LED chip with which the laminating of the CHITSU-ized gallium system compound semiconductor suitable for luminescence of a blue system was carried out to drawing 1 , and the cross-section explanatory view of the LED chip are shown.
[0021] The semi-conductor light emitting device of this invention has the description in the LED chip 30 of the semi-conductor light emitting device which mounts an LED chip and is formed being formed very thinly, as the explanatory view of a chip mold light emitting device is shown in drawing 1 (a) - (b). As this LED chip 30 shown to drawing 1 (c) in a cross-section explanatory view, a substrate 1 is made thin and thickness T from the rear face of a substrate 1 to the top face of p lateral electrode is formed very thinly with 50 micrometers or less. Although the minimum of this thickness T is so desirable that it is small, if there are about 2-3 micrometers of thickness of the semi-conductor layer by which a laminating is carried out and about 1-2 micrometers in the current diffusion layer which is not illustrated, thickness of the p lateral electrode 8, etc. are taken into consideration, about 3-5 micrometers is required at least.
[0022] Although the basic structure of a chip mold light emitting device is the same as the conventional structure The LED chip 30 is mounted on one terminal electrode 32 of the insulating substrate 31 which consists of ceramics with which the terminal electrodes 32 and 33 were formed in both ends. The n lateral electrode 9 of the LED chip 30 The 1st terminal electrode 32, Wirebonding according [the p lateral electrode 8] to the gold streak 34 as a connecting means etc. respectively with the 2nd terminal electrode 33 is made, and it is formed by covering the perimeter with the resin package 35. Since, as for the chip mold light emitting device of this invention, the LED chip 30 is formed very thinly with about 50 micrometers or less as mentioned above, the thickness from the rear face of an insulating substrate 31 to the top face of the resin package 35 is also formed very thinly with 0.5m or less.
[0023] The p lateral electrode 8 be electrically connect through the current diffusion layer which the semi-conductor laminating section 10 in which thickness form a luminous layer in the front face of the substrate 1 which consist of sapphire (aluminum2 O3 single crystal)

which be about 10-50 micrometers as a cross section explanatory view be show in drawing 1 (c) be form, and the LED chip 30 do not illustrate in the p form layer 5 by the side of the front face. Moreover, the n lateral electrode 9 is formed so that it may connect with the n form layer 3 which a part of semi-conductor laminating section 10 is removed, and is exposed electrically. The semi-conductor laminating section 10 is the GaN and/or AlGaN system (it means that the ratio of aluminum and Ga may change variously) of n form used as the low-temperature buffer layer which consists of GaN, and a cladding layer. The ingredient with which the n form layer 3 and bandgap energy which consist of a laminated structure of the same compound semiconductor below become smaller than that of a cladding layer, For example, the p form layer (cladding layer) 5 which consists of the barrier layer 4 which consists of an InGaN system compound semiconductor and an AlGaN system compound semiconductor layer of p form, and/or a GaN layer is constituted by carrying out a laminating one by one on a substrate 1, respectively.

[0024] In order to manufacture this LED chip 30, as shown in drawing 2 R> 2 (a) On the silicon on sapphire 1 of the shape of a wafer whose thickness is about 100-300 micrometers, by for example, the organic metal chemical-vapor-deposition method (MOCVD law) Reactant gas and required dopant gas are introduced, about 1-5 micrometers is grown epitaxially in the n form layer 3, and about 0.2-1 micrometer grows epitaxially about 0.05-0.3 micrometers and the p form layer 5 in a barrier layer 4, respectively. Then, when establishing a current diffusion layer, it alloys by carrying out the laminating of nickel and the Au with vacuum deposition etc., respectively, and carrying out a sinter, and forms in the thickness of about 2-100nm.

[0025] Subsequently, the p lateral electrode 8 which carries out the laminating of Ti and the Au and consists of a laminated structure of both metals so that prepare the resist film in a front face, a part of semi-conductor layer in which carried out patterning and the laminating was carried out by reactive ion etching by chlorine gas etc. may be removed as shown in drawing 2 (b), the n form layer 3 may be exposed, for example, it may connect with the p form layer 5 electrically by the lift-off method is formed. Moreover, the n lateral electrode 9 which consists of an alloy layer of both metals is formed by carrying out the laminating of Ti and the aluminum, respectively, and carrying out a sinter by the lift-off method, similarly, so that it may connect with the n form layer 3 electrically.

[0026] Next, as shown in drawing 2 (c), the adhesives 37, such as a wax which becomes the side in which the n lateral electrode 9 and the p lateral electrode 8 were formed from a ****** low etc. at low temperature, are applied, and the support substrate 36 with which thickness consists of a wafer-like aluminum plate by about 100-300 micrometers is stuck. As a support substrate 36, even if it is not an aluminum plate, they have a mechanical strength in a wafer condition, and if insulating substrates, such as other metal plates, an epoxy resin plate, and ceramics, etc. are ingredients easy later to carry out cutting separation at a chip, they are good anything. However, when making the support substrate mentioned later remain and using it as one electrode, it is desirable that use a metal plate and adhesives also use electroconductive glue (in this case, n lateral electrode is prepared in n form layer which removes a substrate 1 and is exposed). Bond strength is obtained to some extent and adhesives can remove easily after that, and they are good anything. [of others in case such a conductive ingredient is required] Moreover, the approach of removing just considers selective etching as a semi-conductor layer also by the approach by chemical treatments, such as an etching reagent.

[0027] Then, the support substrate 36 side is stuck on a wrapping plate with a wax etc., a silicon-on-sapphire side is shown to spite a grinder, a wrapping plate is rotated, and silicon on sapphire 1 is ground. In the place where the thickness of silicon on sapphire 1 became thin at about 10-50 micrometers, polish is stopped, it removes from a wrapping plate, and cutting separation is carried out at each chip. Subsequently, by pasting up with adhesives, mounting the chip by which cutting separation was carried out on the insulating substrate 31 for chip mold light emitting devices, so that silicon on sapphire 1 may become a rear face, and dipping it in a molten bath etc. after that, as shown in drawing 1 (a) - (b), a wax is melted and a support substrate is removed. Consequently, the LED chip 30 of a super-thin shape mounted on the insulating substrate 31 etc. is obtained.

[0028] [in the middle of the handling which forms an LED chip according to this invention] It is held by support substrates, such as substrates, such as sapphire which carries out the laminating of the semi-conductor layer, or an aluminum plate. Since a support substrate is removed after a wafer process is advanced, cutting separation is carried out at each chip and a chip is mounted on the condition of the purpose of use, maintaining a temporary mechanical strength, The LED chip of a super-thin shape is obtained without damaging by the production process or making the semi-conductor layer which contributes to luminescence produce a crack etc.

[0029] In the above-mentioned example, although a part of silicon on sapphire was made to remain, like silicon on sapphire, in the case of an electric insulating substrate, the part of the substrate may all be removed and the n form layer 3 may be exposed. In that case, the electrode metal with which ohmic contact is obtained is prepared in the front face of the exposed semi-conductor layer, for example, while is shown in drawing 1 , and if an LED chip is mounted with electroconductive glue on the terminal electrode 32, the n form layer 3 will be directly connected with the 1st terminal electrode 32 electrically. Therefore, what is necessary is to etch a part of semi-conductor laminating section 10 by which the laminating was carried out, not to expose the n form layer 3, and to form only the p lateral electrode 8, as shown in drawing 1 (c). Therefore, while the production process of the LED chip 30 is also simplified, it can make an assembly there is also little wirebonding after mounting the LED chip 30, and easy. In this case, since the electrode prepared in the front face of the exposed semi-conductor layer is prepared in the state of the wafer from which silicon on sapphire etc. was removed, it can be performed at the same process as the semi-conductor light emitting device which carries out the laminating of the semi-conductor layer to the usual conductive semi-conductor substrate.

[0030] Moreover, the semi-conductor light emitting device which uses the LED chip of a super-thin shape of this invention mounts an LED chip not only at the above-mentioned chip mold light emitting device but at the tip of a lead, and can use it similarly in the light emitting device of the ramp type covered with a dome-like resin package, and the light emitting device directly mounted on the circuit board etc. as a short ramp-type light emitting device or a thin light emitting device.

[0031] Moreover, although the electrical installation of each electrode of the LED chip 30 and each terminal electrodes 32 and 33 of an insulating substrate 31 is made by wirebonding in the example shown in drawing 1 In making the light in which the substrate of the LED chip 30 emits light like the above-mentioned silicon on sapphire or a GaP substrate penetrate It can connect directly electrically by the connecting means of the bump 38 who consists of a pewter, silver, etc. as shown in drawing 3 , or electroconductive glue, and light can be taken out from the rear-face side of the substrate of the LED chip 30. In order to obtain a light emitting device as shown in drawing 3 , after sticking and chip-izing the support substrate 36 as mentioned above, the support substrate and the opposite side of the LED chip 30 are adsorbed by an adsorption collet etc., it is immersed in a molten bath etc., and adhesives are melted, and after removing a support substrate, it is obtained by mounting and soldering on the bump on an insulating substrate 31 etc. Since the need for wirebonding is lost with such structure, it can thin-shape-ize further. In addition, in drawing 3 , the same sign is given to the same part as drawing 1 . Moreover, this structure is not limited to the light emitting device which consists of a CHITSU-ized gallium system compound semiconductor. That is, if the ingredient which lessens the absorption of light in the substrate, and/or what has thin thickness are used for the substrate of an LED chip, it can consider as a very thin semi-conductor light emitting device by making LED chips, such as GaP and GaAs, into the structure which takes out two electrodes from one side, without carrying out wirebonding.

[0032] Furthermore, although it is the double heterojunction structure where a barrier layer 4 is pinched in the n form layer 3 and the p

form layer 5, in the example shown in drawing 1 , n form layer and p form layer are the same also at the semi-conductor light emitting device of the pn junction structure joined directly. Moreover, the ingredient of the semi-conductor layer by which a laminating is carried out is also an example, and is not limited to the ingredient. Furthermore, in the above-mentioned example, although it was the example by which the laminating of the semi-conductor layer was carried out on the substrate of insulation, such as silicon on sapphire, when the laminating of the semi-conductor layer is carried out on an insulating substrate, it does not restrict. Namely, as the example by which the laminating of the p form GaP layer 12 was carried out to drawing 4 on the n form GaP substrate 11, the p lateral electrode 13 was formed and the GaP substrate 11 was made thin is shown Also in the semi-conductor light emitting device by which the laminating of the semi-conductor layer is carried out on conductive substrates, such as GaP and a GaAs substrate Thin semi-conductor light emitting devices, such as green, yellow, red, and infrared rays, are obtained by sticking a support substrate similarly, grinding substrates, such as GaP and GaAs, making it thin, and removing a support substrate, after mounting by turning the polished surface down. In addition, after grinding the electrode by the side of a rear face, it is prepared in the whole surface by vapor-depositing an electrode metal to a polished surface in the state of a wafer.

[0033] The example shown in drawing 5 is an example made to remain as it is without removing the support substrate 36. That is, if a support substrate is also included in this case, it will not become the LED chip of a super-thin shape, but like the semi-conductor light emitting device of the above-mentioned blue system, even when the laminating of the semi-conductor layer is carried out on an insulating substrate, it can consider as the structure where the n lateral electrode 9 and the p lateral electrode 8 are taken out from both sides of an LED chip, respectively.

[0034] After carrying out the laminating of the n form layer 3, a barrier layer 4, and the p form layer 5 to silicon-on-sapphire top 1 one by one and forming the semi-conductor laminating section 10 as shown in above-mentioned drawing 1 (c) in order to manufacture the LED chip of this structure, the metal membrane (not shown) which consists of a p form layer 5 and an alloy layer of nickel and Au which is easy to take ohmic contact is prepared in the whole surface. And the metal plate which consists of aluminum as a support substrate 36 etc. with electroconductive glue (not shown), such as Ag paste, is stuck after that. Using the technique which grinds the silicon on sapphire of the after that above-mentioned, and is made thin, silicon on sapphire is ground and it removes completely. And patterning of the alloy layer of Ti and Au is prepared and carried out to the front face of the n form layer 3 exposed by removal of silicon on sapphire, and the n lateral electrode 9 is formed in it. Then, as shown to each chip by by carrying out cutting separation at drawing 5 , the support substrate 36 stuck on the p form layer 5 side can be used as the p lateral electrode 8, and the n lateral electrode 9 and the p lateral electrode 8 can be formed in both sides of an LED chip, respectively. In addition, since it is not necessary to make light able to penetrate, and light is not necessarily taken out from the front-face side of the semi-conductor layer by which the laminating was carried out in this case and it can consider as a direct electrode, diffusing a current for the metal membrane (not shown) which consists of an alloy layer of nickel and Au like the above-mentioned current diffusion layer, it can form thickly enough.

[0035] Consequently, it sets to the semi-conductor light emitting device by which the laminating of the semi-conductor layer is carried out on the substrate of the conventional insulation. Although both n lateral electrode and p lateral electrode must be prepared in the front-face side of a substrate and both must be connected by wirebonding, by making it this structure p lateral electrode and n lateral electrode can be taken out from both sides of an LED chip, respectively, one electrode is electrically connected only by carrying out die bonding of the LED chip on a lead or a terminal electrode, and wirebonding requires only one side. And since metal substrates, such as aluminum, are used for the substrate to stick, unlike the conductive substrate which consists of a semi-conductor, a metal substrate can be used as an electrode as it is, and it is cheaply obtained by the very easy production process. That is, although it is necessary to take ohmic contact also to the opposite side of a semi-conductor substrate, and to prepare an electrode metal in it while obtaining ohmic contact with the semi-conductor substrate in the attachment side, to stick a conductive semi-conductor substrate, it is because what is necessary is just to stick the metal substrate 36 with electroconductive glue according to this invention.

[0036] Moreover, since it is not necessary to prepare both electrodes in a luminescence side side by making it this structure, the cutoff area of the light by the electrode decreases, the amount of luminescence required of a small chip area is obtained, the number of the chip which can be taken from the wafer which is increases, and it contributes to a cost cut. Furthermore, since the electrode by the side of a rear face is prepared all over a chip, ohmic contact in a semi-conductor layer is easy to be acquired. That a dopant cannot enter fully easily, since resistance is strong, that an electrode metal is prepared in the whole surface contributes very greatly especially the CHITSU-ized gallium system compound semiconductor of p form to improvement in electrical characteristics. Although there are some which prepare a contact hole in a part of silicon on sapphire, and take one electrode from the rear-face side of a substrate conventionally, the structure where an electrode metal is moreover prepared all over p form layer has the advantage of raising sharply the effectiveness of diffusing a current, all over the CHITSU-ized gallium system compound semiconductor layer by this invention.

[0037]

[Effect of the Invention] According to this invention, since the LED chip is formed very thinly, the semi-conductor light emitting device of a super-thin shape which matched the small and light demand of the latest electronic equipment is obtained. Consequently, the light source used for the switch carbon button of pocket devices, such as a portable telephone and PHS, etc. can be made very thin, and it contributes to small and light-ization of electronic equipment greatly.

[0038] Furthermore, since the substrate of an LED chip is made very thin, even when the substrate consists of an ingredient which absorbs the light which emits light with an LED chip, the absorption of light decreases, it can use by reflection, the light which can be taken out outside comes out comparatively, and a certain external luminous efficiency of light which progressed to the substrate side improves.

[0039] Furthermore, according to this invention, the LED chip which can take out n lateral electrode and p lateral electrode separately, respectively is obtained from both sides of a chip only by sticking a metal substrate on the front face of the semi-conductor layer by which the laminating was carried out directly also by the light emitting device which must carry out the laminating of the semi-conductor layer on an insulating substrate. Therefore, while it is not necessary to prepare the electrode in consideration of ohmic contact in both sides of a semi-conductor substrate like [in the case of sticking a semi-conductor substrate] and being cheaply obtained by the easy production process, also when assembling the obtained LED chip, wirebonding is one side, ends, and it becomes very easy like an erector and it contributes to a cost cut.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross section and flat-surface explanatory view of 1 operation gestalt of this invention. [of a semi-conductor light emitting device]
[Drawing 2] It is drawing showing the production process of the LED chip of drawing 1 .
[Drawing 3] It is the cross-section explanatory view showing the modification of the semi-conductor light emitting device of drawing 1 .
[Drawing 4] It is the strabism explanatory view of other examples of structure of the LED chip used for drawing 1 .
[Drawing 5] It is the cross-section explanatory view of the LED chip of other operation gestalten of the semi-conductor light emitting device of this invention.
[Drawing 6] It is the strabism explanatory view of an example of the conventional semi-conductor light emitting device.
[Drawing 7] It is the cross-section explanatory view of the conventional chip mold light emitting device.
[Description of Notations]
1 Substrate
3 N Form Layer
4 Barrier Layer
5 P Form Layer
8 P Lateral Electrode
9 N Lateral Electrode
10 Semi-conductor Laminating Section
30 LED Chip
31 Insulating Substrate
32 Terminal Electrode
33 Terminal Electrode
34 Gold Streak
35 Resin Package

[Translation done.]

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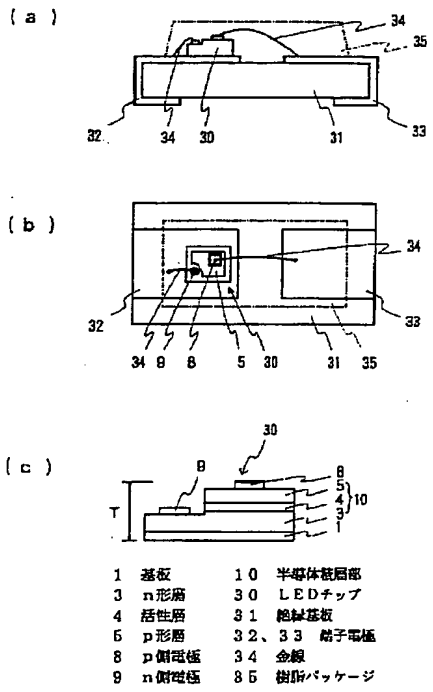
最終頁に続く

(54)【発明の名称】　半導体発光素子およびその製法

(57)【要約】

【課題】　半導体を積層する基板を非常に薄くするか、もしくはなくすることにより、ＬＥＤチップの厚さを薄くし、薄型化した半導体発光素子およびそれを製造する方法を提供する。

【解決手段】　発光層を形成すべく半導体層３、４、５が積層される発光素子チップ３０を有し、前記発光素子チップの前記半導体層が積層される方向の厚さが５０μｍ以下に形成されている。チップ型発光素子とする場合は、両端部に端子電極３２、３３が設けられた絶縁性基板３１と、該絶縁性基板上にマウントされると共に一方の電極（ｎ側電極９）が前記端子電極の一方３２と電気的に接続される発光素子チップ３０と、該発光素子チップの他方の電極（ｐ側電極８）を前記端子電極の他方３３と電気的に接続するワイヤ３４と、前記発光素子チップの周囲を被覆する樹脂パッケージ３５からなっている。



【特許請求の範囲】
【請求項１】　発光層を形成すべく半導体層が積層される発光素子チップを有する半導体発光素子であって、前記発光素子チップの前記半導体層が積層される方向の厚さが５０μｍ以下である半導体発光素子。
【請求項２】　両端部に端子電極が設けられる絶縁基板と、該絶縁基板上にマウントされると共に一方の電極が前記端子電極の一方と電気的に接続される発光素子チップと、該発光素子チップの他方の電極を前記端子電極の他方と電気的に接続する接続手段と、前記発光素子チップの周囲を被覆する樹脂パッケージとからなる請求項１記載の半導体発光素子。
【請求項３】　金属基板上に発光層を形成すべく積層される半導体層の表面側が導電性接着剤により貼着され、該積層される半導体層の前記貼着される側と反対側の半導体層側に該半導体層と電気的に接続して電極金属が設けられてなる半導体発光素子。
【請求項４】　前記積層される半導体層がチッ化ガリウム系化合物半導体からなる請求項３記載の半導体発光素子。
【請求項５】　（ａ）ウェハ状の基板上に発光層を形成すべく半導体層を積層して半導体積層部を形成し、
（ｂ）該半導体積層部の表面側に電極を形成した後に支持基板を貼着し、（ｃ）前記半導体積層部が設けられた基板を裏面側から研磨し、（ｄ）ウェハから各発光素子チップに切断分離し、（ｅ）該発光素子チップの研磨された面を下にしてマウントした後に前記支持基板を除去し、（ｆ）露出した前記半導体積層部の表面側の電極にワイヤボンディングをすることを特徴とする半導体発光素子の製法。
【請求項６】　請求項５記載の方法において、（ｂ）工程で前記支持基板に金属板を用いて前記半導体積層部の第１導電形半導体層に電気的に接続されるように導電性接着剤により貼着し、（ｅ）～（ｆ）工程で該支持基板側を下側にして前記発光素子チップをマウントし、前記研磨された基板もしくは該研磨により露出する半導体積層部の第２導電形半導体層と外部電極端子とを電気的に接続する半導体発光素子の製法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は発光層を形成すべく半導体層が積層される半導体発光素子チップの薄型化に関する。さらに詳しくは、半導体層が積層される方向の厚さを非常に薄くし、発光面積を充分に確保した高輝度で超薄型の半導体発光素子およびその製法に関する。
【０００２】
【従来の技術】従来半導体発光素子の発光素子チップ（以下、ＬＥＤチップという）は、たとえば図６（ａ）に示されるように、ｎ形のＧａＰ基板１１上にｐ形のＧａＰ層１２がエピタキシャル成長されてｐｎ接合を形成し、積層された半導体層の表面側にｐ側電極１３、基板の裏面側にｎ側電極１４が設けられる構造のものが用いられている。
【０００３】また、たとえば青色系の半導体発光素子のように、サファイアなどからなる絶縁性の基板上にチッ化ガリウム系化合物半導体層が積層される構造のものは、図６（ｂ）にそのＬＥＤチップの一例の概略図が示されるように、その表面側にｐ側電極２８およびｎ側電極２９の両方が設けられることにより形成されている。この構造のものは、たとえばウェハ状のサファイア基板２１上にたとえばｎ形のＧａＮがエピタキシャル成長されたｎ形層（クラッド層）２３と、バンドギャップエネルギーがクラッド層のそれよりも小さくなる材料、たとえばＩｎＧａＮ系（ＩｎとＧａの比率が種々変わり得ることを意味する、以下同じ）化合物半導体からなる活性層２４と、ｐ形のＧａＮからなるｐ形層（クラッド層）２５とが積層され、その表面のｐ形層２５に電気的に接続してｐ側電極２８が、積層された半導体層の一部がエッチングされて露出したｎ形層２３と電気的に接続してｎ側電極２９が設けられることにより、ＬＥＤチップが形成されている。
【０００４】これらのＬＥＤチップは、たとえば図６（ａ）に示されるものでは、たとえば２６０μｍ程度四方で３００μｍ程度の厚さに形成され、図６（ｂ）に示される構造のものでは、たとえば３６０μｍ程度四方で、１００μｍ程度の厚さに形成される。そして、これらのＬＥＤチップ３０がたとえば図７に示されるように、両端に端子電極３２、３３が設けられた絶縁基板３１の一方の端子電極３２と一方の電極が電気的に接続されるようにマウントされ、ＬＥＤチップ３０の他方の電極１３が他方の端子電極３３と金線３４によりワイヤボンディングされて、樹脂パッケージ３５などにより被覆されることにより、チップ型の発光素子が形成されている。
【０００５】
【発明が解決しようとする課題】近年、携帯電話機やＰＨＳなどの携帯機器の発展および小形化に伴い、電子部品の小形化の要請が一層高まり、チップ型発光素子においてはとくに薄型のものが要求され、全体の厚さが０．５ｍｍ程度以下のものが要求されている。しかし、従来のＬＥＤチップは前述のように、その厚さが１００～３００μｍ程度はあり、絶縁基板の厚さ、ワイヤボンディングのためのスペース、樹脂パッケージの厚さなどを考慮すると、ＬＥＤチップの厚さが少なくとも０．１ｍｍ程度以下にならないと全体の厚さを０．５ｍｍ程度以下にすることができない。
【０００６】また、ＧａＡｓなどのように、導電性の半導体が基板として用いられるＬＥＤチップは、発光層で発光する光を吸収するものが多く、基板の厚さが厚いと、発光層で発光し四方に放射される光のうち、基板側

に進んだ光が殆ど吸収されて無駄になり、発光効率が低下するという問題がある。

【０００７】さらに、前述の図６（ｂ）に示されるような絶縁性の基板上に半導体層が積層されるＬＥＤチップでは、ＬＥＤチップの裏面側に一方の電極を設けることができず、両方の電極をワイヤボンディングにより接続しなければならない。そのため、小形化の妨げになると共に、組立ての工数増の原因にもなっている。

【０００８】一方、絶縁性の基板上に半導体層が積層されるＬＥＤチップで、劈開性を利用してチップ化することができると共に、両方の電極をワイヤボンディングしなくてＬＥＤチップの両面から電極を取り出すことができるように積層された半導体層の表面に半導体からなる導電性基板を貼着して半導体層を積層するための基板を除去する半導体素子およびその製法が、たとえば特開平９－８４０３号公報に開示されている。しかし、半導体基板を貼着する方法では、積層される半導体層の表面にオーミックコンタクトをとる金属を設けるだけでなく、貼着する半導体基板にもオーミックコンタクトをとることができる金属を設けてから貼着しなければならないと共に、貼着した半導体基板の反対側の面にさらに電極を設けなければならない。このオーミックコンタクトを得るためには半導体基板に適した金属を付着すると共にアニール処理をしなければならず、工数が非常に増加するという問題がある。

【０００９】本発明は、このような問題を解決するためになされたもので、半導体を積層する基板を非常に薄くするか、もしくはなくすることにより、ＬＥＤチップの厚さを薄くし、薄型化した半導体発光素子およびそれを製造する方法を提供することを目的とする。

【００１０】本発明の他の目的は、絶縁性の基板上に半導体層を積層しざるを得ない半導体発光素子においても、ＬＥＤチップの上下両面からそれぞれ電極を取り出すことができると共に、それを少ない工数で簡単に形成し得る構造のＬＥＤチップを有する半導体発光素子およびその製法を提供することにある。

【００１１】

【課題を解決するための手段】本発明による半導体発光素子は、発光層を形成すべく半導体層が積層される発光素子チップを有し、該発光素子チップの前記半導体層が積層される方向の厚さが５０μｍ以下に形成されている。

【００１２】この薄型のＬＥＤチップを形成するには、たとえば後述するように、基板上に半導体層を積層して、その表面側に支持基板を貼着した後に、基板を研磨して薄くするか、なくし、ＬＥＤチップをマウントした後に支持基板を取り除くことにより得られる。ＬＥＤチップが薄くなることにより、全体として薄型の半導体発光素子が得られると共に、基板が薄くなって基板による光の吸収損失を最低限に減少させることができる。

【００１３】両端部に端子電極が設けられる絶縁基板と、該絶縁基板上にマウントされると共に一方の電極が前記端子電極の一方と電気的に接続される発光素子チップと、該発光素子チップの他方の電極を前記端子電極の他方と電気的に接続する接続手段と、前記発光素子チップの周囲を被覆する樹脂パッケージとから構成し、前記発光素子チップに厚さが５０μｍ以下のものを使用することにより、薄型のチップ型発光素子が得られる。ここに接続手段とは、ワイヤによるボンディングや、バンプ、導電性接着剤などによる直接的接続などの電気的に接続できる手段をいう。

【００１４】金属基板上に発光層を形成すべく積層される半導体層の表面側が導電性接着剤により貼着され、該積層される半導体層の前記貼着される側と反対側の半導体層側に該半導体層と電気的に接続して電極金属が設けられておれば、金属基板をそのまま一方の電極として用いることができ、半導体層を積層する際の基板が絶縁性基板であっても、その基板を全部除去することにより露出する半導体層に電極が設けられ、ＬＥＤチップの両面からそれぞれ電極を取り出すことができる。ここに半導体層の表面側とは、後から積層される半導体層の露出面側を意味する。

【００１５】前記積層される半導体層がチッ化ガリウム系化合物半導体からなれば、チッ化ガリウム系化合物半導体はサファイア基板上に半導体層が積層されることが多いため両面から電極を取り出しにくい青色系の半導体発光素子において、両面から電極を取り出すことができるＬＥＤチップを簡単な製造工程により得ることができるためとくに好ましい。

【００１６】ここにチッ化ガリウム系化合物半導体とは、III 族元素のＧａとＶ族元素のＮとの化合物またはIII 族元素のＧａの一部がＡｌ、Ｉｎなどの他のIII 族元素と置換したものおよび／またはＶ族元素のＮの一部がＰ、Ａｓなどの他のＶ族元素と置換した化合物からなる半導体をいう。

【００１７】本発明の半導体発光素子の製法は、（ａ）ウェハ状の基板上に発光層を形成すべく半導体層を積層して半導体積層部を形成し、（ｂ）該半導体積層部の表面側に電極を形成した後に支持基板を貼着し、（ｃ）前記半導体積層部が設けられた基板を裏面側から研磨し、（ｄ）ウェハから各発光素子チップに切断分離し、（ｅ）該発光素子チップの研磨された面を下にしてマウントした後に前記支持基板を除去し、（ｆ）露出した前記半導体積層部の表面側の電極にワイヤボンディングをするものである。この方法によれば、前述の厚さが薄いＬＥＤチップを容易に得ることができる。

【００１８】前記（ｂ）工程で前記支持基板に金属板を用いて前記半導体積層部の第１導電形半導体層に電気的に接続されるように導電性接着剤により貼着し、前記（ｅ）～（ｆ）工程で該支持基板側を下側にして前記発

光素子チップをマウントし、前記研磨された基板もしくは該研磨により露出する半導体積層部の第２導電形半導体層と電気的に接続してワイヤボンディングをすることにより、両面から電極を取り出すことができるＬＥＤチップを容易に得ることができる。

【００１９】ここに第１導電形および第２導電形とは、半導体の極性のｎ形およびｐ形のいずれか一方を第１導電形としたとき、他方のｐ形またはｎ形が第２導電形であることを意味する。

【００２０】

【発明の実施の形態】つぎに、図面を参照しながら本発明の半導体発光素子について説明をする。図１には、たとえば青色系の発光に適するチッ化ガリウム系化合物半導体が積層されたＬＥＤチップを用いた本発明の半導体発光素子の一実施形態の断面および平面説明図と、そのＬＥＤチップの断面説明図が示されている。

【００２１】本発明の半導体発光素子は、たとえば図１（ａ）～（ｂ）にチップ型発光素子の説明図が示されるように、ＬＥＤチップをマウントして形成される半導体発光素子のＬＥＤチップ３０が非常に薄く形成されていることに特徴がある。このＬＥＤチップ３０は、たとえば図１（ｃ）に断面説明図で示されるように、基板１が薄くされて基板１の裏面からｐ側電極の上面までの厚さＴが５０μｍ以下と非常に薄く形成されている。この厚さＴの下限は、小さいほど好ましいが、積層される半導体層の厚さが２～３μｍ程度はあり、図示しない電流拡散層やｐ側電極８の厚さ１～２μｍ程度などを考慮すると、３～５μｍ程度は少なくとも必要である。

【００２２】チップ型発光素子の基本構造は従来の構造と同じであるが、両端に端子電極３２、３３が設けられたセラミックスなどからなる絶縁基板３１の一方の端子電極３２上にＬＥＤチップ３０がマウントされ、ＬＥＤチップ３０のｎ側電極９が第１の端子電極３２と、ｐ側電極８が第２の端子電極３３とそれぞれ接続手段としての金線３４などによるワイヤボンディングがなされ、その周囲が樹脂パッケージ３５により覆われることにより形成されている。本発明のチップ型発光素子は、前述のように、ＬＥＤチップ３０が５０μｍ程度以下と非常に薄く形成されているため、絶縁基板３１の裏面から樹脂パッケージ３５の上面までの厚さも０．５ｍ以下と非常に薄く形成されている。

【００２３】ＬＥＤチップ３０は、図１（ｃ）に断面説明図が示されるように、厚さが１０～５０μｍ程度のサファイア（Al_2O_3 単結晶）などからなる基板１の表面に発光層を形成する半導体積層部１０が形成されて、その表面側のｐ形層５に、図示しない電流拡散層を介してｐ側電極８が電気的に接続されている。また、半導体積層部１０の一部が除去されて露出するｎ形層３に電気的に接続されるようにｎ側電極９が形成されている。半導体積層部１０は、たとえばＧａＮからなる低温バッファ層、クラッド層となるｎ形のＧａＮおよび／またはＡｌＧａＮ系（ＡｌとＧａの比率が種々変わり得ることを意味する、以下同じ）化合物半導体の積層構造からなるｎ形層３、バンドギャップエネルギーがクラッド層のそれよりも小さくなる材料、たとえばＩｎＧａＮ系化合物半導体からなる活性層４、およびｐ形のＡｌＧａＮ系化合物半導体層および／またはＧａＮ層からなるｐ形層（クラッド層）５が、基板１上にそれぞれ順次積層されることにより構成されている。

【００２４】このＬＥＤチップ３０を製造するには、図２（ａ）に示されるように、厚さが１００～３００μｍ程度のウェハ状のサファイア基板１上に、たとえば有機金属化学気相成長法（ＭＯＣＶＤ法）により、反応ガスおよび必要なドーパントガスを導入してｎ形層３を１～５μｍ程度、活性層４を０．０５～０．３μｍ程度、およびｐ形層５を０．２～１μｍ程度、それぞれエピタキシャル成長する。その後、電流拡散層を設ける場合は、たとえばＮｉおよびＡｕをそれぞれ真空蒸着などにより積層してシンターすることにより合金化し、２～１００ｎｍ程度の厚さに形成する。

【００２５】ついで、表面にレジスト膜を設け、パターニングをして塩素ガスなどによる反応性イオンエッチングにより、積層された半導体層の一部を図２（ｂ）に示されるように除去してｎ形層３を露出させ、たとえばリフトオフ法により、ｐ形層５と電気的に接続されるようにＴｉとＡｕとを積層して両金属の積層構造からなるｐ側電極８を形成する。また同様に、たとえばリフトオフ法により、ｎ形層３と電気的に接続されるように、ＴｉとＡｌをそれぞれ積層してシンターすることにより両金属の合金層からなるｎ側電極９を形成する。

【００２６】つぎに、図２（ｃ）に示されるように、ｎ側電極９およびｐ側電極８が設けられた側に低温で融けるロウなどからなるワックスなどの接着剤３７を塗布して、厚さが１００～３００μｍ程度でウェハ状のアルミニウム板からなる支持基板３６を貼着する。支持基板３６としては、アルミニウム板でなくても、他の金属板、エポキシ樹脂板、セラミックスなどの絶縁基板など、ウェハ状態での機械的強度を有し、後でチップに切断分離するのに容易な材料であれば何でもよい。ただし、後述する支持基板を残存させて一方の電極として使用する場合には、金属板を使用し、接着剤も導電性接着剤を使用することが好ましい（この場合は、ｎ側電極は基板１を除去して露出するｎ形層に設けられる）。接着剤も、このような導電性材料が要求される場合の他は、接着強度がある程度得られ、その後容易に除去できるものであれば何でもよい。また、除去する方法は、エッチング液などの化学処理による方法でも、半導体層と選択エッチングをすることができればよい。

【００２７】その後、支持基板３６側をラッピング板にワックスなどにより貼着し、サファイア基板側を研磨盤

に当て付け、ラッピング板を回転させてサファイア基板１を研磨する。サファイア基板１の厚さが１０～５０μｍ程度に薄くなったところで、研磨を中止し、ラッピング板から取り外し、各チップに切断分離する。ついで、切断分離されたチップを図１（ａ）～（ｂ）に示されるように、たとえばチップ型発光素子用の絶縁基板３１上に、サファイア基板１が裏面になるように接着剤により接着してマウントし、その後湯などに浸すことによりワックスを溶かして支持基板を除去する。その結果、絶縁基板３１上などにマウントされた超薄型のＬＥＤチップ３０が得られる。

【００２８】本発明によれば、ＬＥＤチップを形成するハンドリングの途中においては、半導体層を積層するサファイアなどの基板、またはアルミニウム板などの支持基板により保持され、一応の機械的強度を保ちながらウェハ工程が進められ、各チップに切断分離され、使用目的の状態にチップがマウントされた後に支持基板が除去されるため、製造工程で破損したり、発光に寄与する半導体層にクラックなどを生じさせることなく超薄型のＬＥＤチップが得られる。

【００２９】前述の例では、サファイア基板の一部を残存させたが、サファイア基板のように、電気的絶縁性の基板の場合、その基板の部分を全部除去してｎ形層３を露出させてもよい。その場合、その露出した半導体層の表面にオーミックコンタクトが得られる電極金属を設け、たとえば図１に示される一方の端子電極３２上に導電性接着剤によりＬＥＤチップをマウントすれば直接ｎ形層３が第１の端子電極３２と電気的に接続される。そのため、図１（ｃ）に示されるように、積層された半導体積層部１０の一部をエッチングしてｎ形層３を露出させる必要がなく、ｐ側電極８のみを形成しておけばよい。そのため、ＬＥＤチップ３０の製造工程も単純化されると共に、ＬＥＤチップ３０をマウントした後のワイヤボンディングも少なくて簡単に組立てをすることができる。この場合、露出した半導体層の表面に設けられる電極は、サファイア基板などが除去されたウェハの状態で設けられるため、通常の導電性の半導体基板に半導体層を積層する半導体発光素子と同様の工程で行うことができる。

【００３０】また、本発明の超薄型のＬＥＤチップを使用する半導体発光素子は、前述のチップ型発光素子に限らず、リードの先端にＬＥＤチップをマウントし、ドーム状の樹脂パッケージにより被覆されるランプ型の発光素子や、回路基板などに直接マウントされる発光素子においても同様に背の低いランプ型発光素子や薄型の発光素子として利用できる。

【００３１】また、図１に示される例では、ＬＥＤチップ３０の各電極と絶縁基板３１の各端子電極３２、３３との電気的接続がワイヤボンディングによりなされているが、ＬＥＤチップ３０の基板が前述のサファイア基板やＧａＰ基板などのように発光する光を透過させる場合には、図３に示されるようにハンダや銀などからなるバンプ３８もしくは導電性接着剤などの接続手段により直接電気的に接続してＬＥＤチップ３０の基板の裏面側から光を取り出すことができる。図３に示されるような発光素子を得るには、前述のように支持基板３６を貼着してチップ化した後に、ＬＥＤチップ３０の支持基板と反対側を吸着コレットなどにより吸着して湯などに浸漬して接着剤を溶かし、支持基板を除去してから絶縁基板３１上のバンプなどの上にマウントしてハンダ付けすることにより得られる。このような構造にすることにより、ワイヤボンディングの必要がなくなるため、一層薄型化することができる。なお、図３において図１と同じ部分には同じ符号を付してある。また、この構造はチッ化ガリウム系化合物半導体からなる発光素子には限定されない。すなわち、ＬＥＤチップの基板にその基板での光の吸収を少なくする材料および／または厚さの薄いものを使用すれば、ＧａＰやＧａＡｓなどのＬＥＤチップでも片面から２つの電極を取り出す構造にすることにより、ワイヤボンディングをせずに非常に薄型の半導体発光素子とすることができる。

【００３２】さらに、図１に示される例では、ｎ形層３とｐ形層５とで活性層４が挟持されるダブルヘテロ接合構造であるが、ｎ形層とｐ形層とが直接接合するｐｎ接合構造の半導体発光素子でも同様である。また、積層される半導体層の材料も一例であって、その材料には限定されない。さらに、前述の例では、サファイア基板などの絶縁性の基板上に半導体層が積層された例であったが、絶縁性基板上に半導体層が積層される場合に限らない。すなわち、図４にｎ形ＧａＰ基板１１上にｐ形ＧａＰ層１２が積層され、ｐ側電極１３が形成されてＧａＰ基板１１が薄くされた例が示されているように、ＧａＰやＧａＡｓ基板などの導電性基板上に半導体層が積層される半導体発光素子においても、同様に支持基板を貼着してＧａＰやＧａＡｓなどの基板を研磨して薄くし、その研磨面を下にしてマウントした後に支持基板を除去することにより、緑色、黄色、赤色、赤外などの薄型の半導体発光素子が得られる。なお、裏面側の電極は、研磨した後にウェハの状態で研磨面に電極金属を蒸着することにより、全面に設けられる。

【００３３】図５に示される例は、支持基板３６を除去しないで、そのまま残存させる例である。すなわち、この場合は支持基板も含めると超薄型のＬＥＤチップとはならないが、前述の青色系の半導体発光素子のように、絶縁性の基板上に半導体層が積層される場合でも、ＬＥＤチップの両面からそれぞれｎ側電極９およびｐ側電極８が取り出される構造とすることができる。

【００３４】この構造のＬＥＤチップを製造するには、前述の図１（ｃ）に示されるように、サファイア基板上１にｎ形層３、活性層４、ｐ形層５を順次積層して半導

体積層部１０を形成した後、ｐ形層５とオーミックコンタクトをとりやすいＮｉとＡｕの合金層からなる金属膜（図示せず）を全面に設ける。そしてその後に、Ａｇペーストなどの導電性接着剤（図示せず）により支持基板３６としてのＡｌなどからなる金属板を貼着する。その後前述のサファイア基板を研磨して薄くする技術を利用して、サファイア基板を研磨して完全に除去する。そして、サファイア基板の除去により露出したｎ形層３の表面に、たとえばＴｉとＡｕの合金層を設けてパターニングしてｎ側電極９を形成する。その後、各チップに切断分離することにより、図５に示されるように、ｐ形層５側に貼着される支持基板３６をｐ側電極８とし、ＬＥＤチップの両面にｎ側電極９とｐ側電極８とをそれぞれ設けることができる。なお、この場合は積層された半導体層の表面側から光を取り出すわけではないので、ＮｉとＡｕの合金層からなる金属膜（図示せず）を前述の電流拡散層のように電流を拡散させながら光を透過させる必要がなく、直接電極とすることができるため、充分に厚く形成することができる。

【００３５】その結果、従来の絶縁性の基板上に半導体層が積層される半導体発光素子においては、ｎ側電極およびｐ側電極の両方を基板の表面側に設けて、両方をワイヤボンディングにより接続しなければならないが、この構造にすることにより、ＬＥＤチップの両面からそれぞれｐ側電極とｎ側電極とを取り出すことができ、ＬＥＤチップをリードもしくは端子電極上にダイボンディングするだけで一方の電極が電気的に接続され、ワイヤボンディングは一方だけですむ。しかも、貼着する基板にＡｌなどの金属基板を用いているため、半導体からなる導電性基板と異なり、金属基板をそのまま電極として使用することができ、非常に簡単な製造工程で安価に得られる。すなわち、導電性の半導体基板を貼着する場合はその貼着面における半導体基板とのオーミックコンタクトを得る必要があると共に、半導体基板の反対面にもオーミックコンタクトをとって電極金属を設ける必要があるが、本発明によれば金属基板３６を導電性接着剤により貼着するだけでよいからである。

【００３６】また、この構造にすることにより、発光面側に両方の電極を設ける必要がないため、電極による光の遮断面積が少なくなり、小さいチップ面積で必要な発光量が得られ、１枚のウェハから取れるチップの個数が多くなり、コストダウンに寄与する。さらに、裏面側の電極はチップの全面に設けられるため、半導体層とのオーミック接触が得られやすい。とくにｐ形のチッ化ガリウム系化合物半導体はドーパントが充分に入り難く抵抗が大きいため、全面に電極金属が設けられることは、電気的特性の向上に非常に大きく寄与する。従来、サファイア基板の一部にコンタクト孔を設けて一方の電極を基板の裏面側から取るものもあるが、本発明によるチッ化ガリウム系化合物半導体層の全面に、しかもｐ形層の全面に電極金属が設けられる構造は、電流を拡散させる効果を大幅に向上させるという利点がある。

【００３７】

【発明の効果】本発明によれば、ＬＥＤチップが非常に薄く形成されているため、最近の電子機器の軽薄短小の要求にマッチした超薄型の半導体発光素子が得られる。その結果、携帯電話機やＰＨＳなどの携帯機器のスイッチボタンなどに用いられる光源を非常に薄くすることができ、電子機器の軽薄短小化に大きく寄与する。

【００３８】さらに、ＬＥＤチップの基板が非常に薄くされているため、その基板がＬＥＤチップで発光する光を吸収する材料からなる場合でも、その光の吸収が少なくなり、基板側に進んだ光も反射により利用することができ、外部に取り出せる光の割合である外部発光効率が向上する。

【００３９】さらに、本発明によれば、絶縁性の基板上に半導体層を積層しなければならない発光素子でも、積層された半導体層の表面に金属基板を直接貼着するだけで、チップの両面からｎ側電極とｐ側電極をそれぞれ別々に取り出すことができるＬＥＤチップが得られる。そのため、半導体基板を貼着する場合のように、オーミックコンタクトを考慮した電極を半導体基板の両面に設ける必要がなく、簡単な製造工程により安価に得られると共に、得られたＬＥＤチップを組み立てる場合も、ワイヤボンディングは一方ですみ、組立工程が非常に容易になり、コストダウンに寄与する。

【図面の簡単な説明】

【図１】本発明の半導体発光素子の一実施形態の断面および平面説明図である。

【図２】図１のＬＥＤチップの製造工程を示す図である。

【図３】図１の半導体発光素子の変形例を示す断面説明図である。

【図４】図１に用いられるＬＥＤチップの他の構造例の斜視説明図である。

【図５】本発明の半導体発光素子の他の実施形態のＬＥＤチップの断面説明図である。

【図６】従来の半導体発光素子の一例の斜視説明図である。

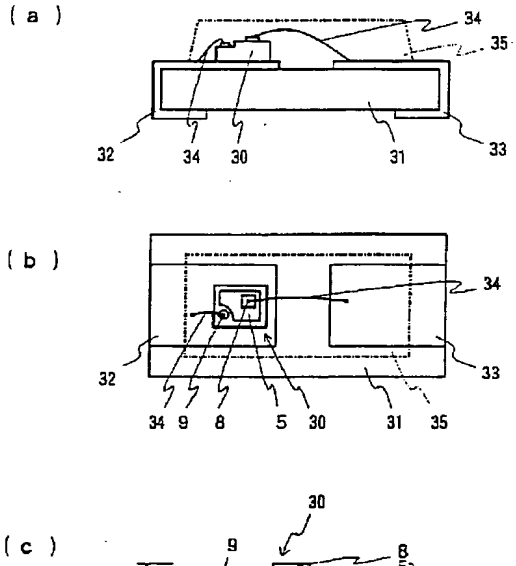
【図７】従来のチップ型発光素子の断面説明図である。

【符号の説明】

１　基板
３　ｎ形層
４　活性層
５　ｐ形層
８　ｐ側電極
９　ｎ側電極
１０　半導体積層部
３０　ＬＥＤチップ
３１　絶縁基板

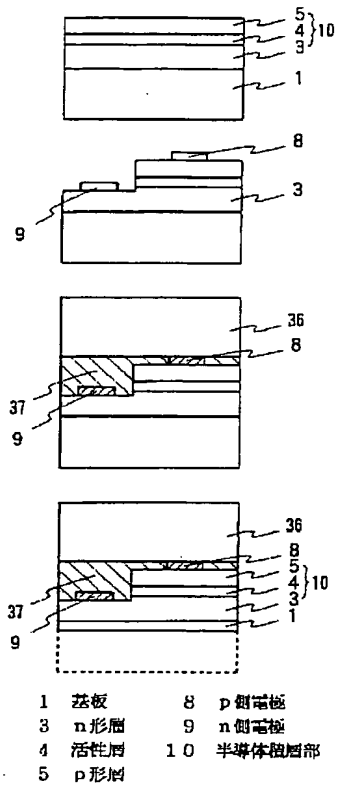
３２　端子電極
３３　端子電極
３４　金線
３５　樹脂パッケージ

【図１】



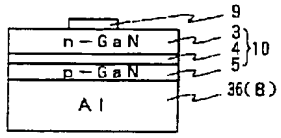
１　基板　　１０　半導体積層部
３　ｎ形層　　３０　ＬＥＤチップ
４　活性層　　３１　絶縁基板
５　ｐ形層　　３２、３３　端子電極
８　ｐ側電極　　３４　金線
９　ｎ側電極　　３５　樹脂パッケージ

【図２】

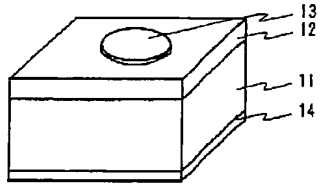


１　基板　　８　ｐ側電極
３　ｎ形層　　９　ｎ側電極
４　活性層　　１０　半導体積層部
５　ｐ形層

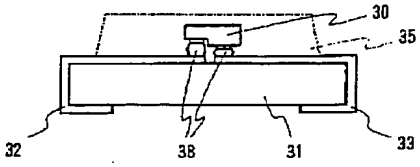
【図５】



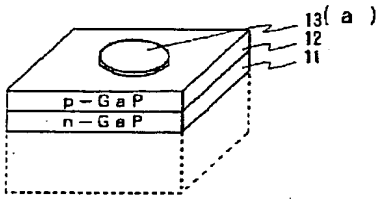
【図６】



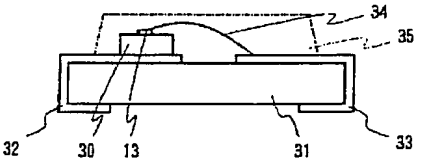
【図３】



【図４】



【図７】



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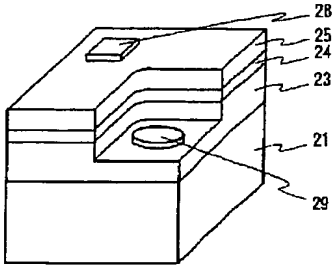

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